PATENT ABSTRACTS OF JAPAN

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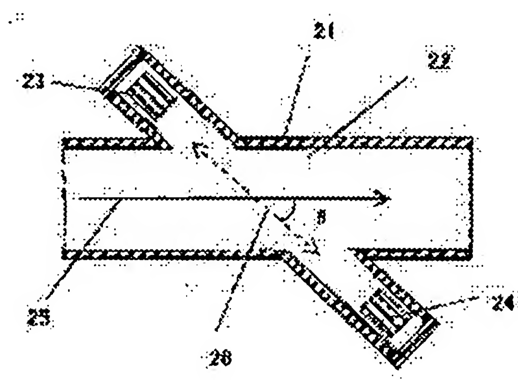
(54) FLOW METER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a flow meter with high accuracy.

SOLUTION: A time during which an ultrasonic wave reciprocates between a pair of ultrasonic converters 23 and 24 arranged on the upper stream and the lower stream sides is measured. Thereby an offset value generated between the pair of ultrasonic converters is corrected at any time, flow velocity of a fluid can be accurately measured, and a flow meter with high accuracy can be realized.



21 超音波流量計
22 流路
23、24 超音波変換器

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the ultrasonic flowmeter which measures the flow rate of a fluid.
[0002]
[Description of the Prior Art] Conventionally, there is a flowmeter 1 as shown in drawing 5 as this kind of a flowmeter. Drawing 5 showed the sectional view, installed the ultrasonic transducers 3 and 4 of a pair in the upstream and the downstream of the passage 2 where a fluid flows face to face through the fluid, measured the rate of flow of a fluid from the time difference of the ultrasonic transducer 3 of a pair, and the travelling period of the supersonic wave which spreads between four, calculated the flow rate, and was taken as the flowmeter. In addition, the piece arrow head 5 (continuous line) in drawing shows the direction where a fluid flows, and both the arrow heads 6 (broken line) show the direction which a supersonic wave spreads. In addition, the direction where a fluid flows, and the direction which a supersonic wave spreads cross on square theta.
[0003] the drive wave of the shape of a rectangle when driving the ultrasonic transducer 3 (or 4) of the upstream (or downstream) to drawing 6 -- a received wave when 7 and the ultrasonic transducer 4 (or 3) of the downstream (or upstream) receive -- 8 is shown. Time amount is shown on an axis of abscissa, and an electrical potential difference is shown on an axis of ordinate. In addition, the striping 9 (broken line) in drawing shows the programmed voltage (Vref) of a comparator. in addition, as for the programmed voltage 9 (Vref) of a comparator, a comparator does not malfunction by the noise signal -- as -- a received wave -- it has set up so that it may become between the crest (V3) of the 3rd received electrical potential difference of 8, and the crests (V4) of the 4th received electrical potential difference. The received wave form 8 was carrying out the ultrasonic transducer 3 and the travelling period Tp of the supersonic wave which spreads between four to to the following zero crossing point 11 (black dot) beyond the programmed voltage 9 of a comparator from the standup point 10 of a drive wave (refer to Tp in drawing). In this case, the true travelling period Ts turns into time amount which deducted a part for 3.5 waves of a received wave (refer to Ti in drawing) from the above-mentioned travelling period Tp. That is, the true travelling period Ts of a supersonic wave was used for the flow rate operation as Ts=Tp-Ti.
[0004]
[Problem(s) to be Solved by the Invention] However, since time amount (Ti) until it is detected was included in the ultrasonic travelling period Tp (= Ts+Ti) by which the conventional flowmeter 1 is measured after a supersonic wave arrives at the front face of the ultrasonic transducer of a receiving side, the error might occur according to the property difference of the ultrasonic transducers 3 and 4 of a pair. That is, while received frequency changed, or receiving sensibility changed with the temperature characteristics, aging, etc. of an ultrasonic transducer and being detected, time amount (Ti) might differ between the ultrasonic transducers of a pair. It had the technical problem that this difference served as an error of an ultrasonic flowmeter, and a flow rate value served as incorrectness.

[0005] That is, it is as follows when distance between the ultrasonic transducers of Vf, the upstream, and the downstream is set [the velocity of propagation of the supersonic wave which spreads / the travelling period of the supersonic wave from an ultrasonic transducer to the ultrasonic transducer of the downstream of the upstream measured / the inside of Tp (du) and a fluid for the travelling period of the supersonic wave from an ultrasonic transducer to the ultrasonic transducer of the upstream of Tp (ud) and the downstream measured] to Ld for the rate of flow of Vs and a fluid.
[0006] Tp -- (-- ud --) -- = -- Ts -- (-- ud --) -- + -- Ti -- (-- d --) -- = -- Ld -- /-- [-- Vs+Vfxcos (theta) --] -- + -- Ti -- (-- d --) -- Tp -- (-- du --) -- = -- Ts -- (-- du --) -- + -- Ti -- (-- u --) -- = -- Ld -- /-- [-- Vs-Vfxcos (theta) --] -- + -- Ti -- (-- u --) -- becoming .
[0007] Here, Ti (d) shows time amount until a supersonic wave spreads Ti (u) and it detects time amount until a supersonic wave spreads and it is detected after arriving at the front face of the ultrasonic transducer of the downstream after arriving at the front face of the ultrasonic transducer of the upstream, respectively. In addition, Ts (ud) and Ts (du) show the travelling period of going-back-and-forth [the supersonic wave measured from the ultrasonic transducer of the upstream, respectively / between the ultrasonic transducers of a pair] truth, and the travelling period of going-back-and-forth [the supersonic wave measured from the ultrasonic transducer of the downstream / between the ultrasonic transducers of a pair] truth.
[0008] From these, since it is Tp(ud)-Ti(d) =Ld/[Vs+Vfxcos (theta)] Vs+Vfxcos(theta) =Ld/[Tp(ud)-Ti (d)], Moreover, since it is Tp(du)-Ti(u) =Ld/[Vs-Vfxcos (theta)], if it becomes Vs-Vfxcos(theta) =Ld/[Tp(du)-Ti (u)] and both sides are subtracted It is canceled and the ultrasonic velocity of propagation Vs in a fluid is 2xVfxcos(theta) ={Ld/[Tp(ud)-Ti (d)]}- {Ld/[Tp(du)-*Ti (u)]}.
[0009] therefore -- = (molecule of the right-hand side) -- Ld -- x -- {-- [-- Tp -- (-- du --) - Ti -- (-- u --) --] - [-- Tp -- (-- ud --) - Ti -- (-- d --) --] --} -- = -- Ld -- x -- {-- [-- Tp -- (-- du --) - Tp -- (-- ud --) --] -- + -- [-- Ti -- (-- d --) - Ti -- (-- u --) --] --} (denominator of the right-hand side) -- = -- [-- Tp -- (-- ud --) - Ti -- (-- d --) --] -- x -- [-- Tp -- (-- du --) -- - -- Ti -- (-- u --) --] -- becoming -- .
[0010] usual -- a case -- Tp -- (-- ud --) -- Tp -- (-- du --) -- > -- > -- Ti -- (-- d --) -- Ti -- (-- u --) -- Tp -- (-- ud --) -- ** -- Tp -- (-- du --) -- it is -- since -- (Denominator of the right-hand side) = -- [-- Tp -- (-- ud --) - Ti -- (-- d --) --] -- x -- [-- Tp -- (-- du --) - Ti -- (-- u --) --] -- = -- Tp -- (-- ud --) -- x -- Tp -- (-- du --) - Tp -- (-- ud --) -- x -- [-- Ti -- (-- d --) -- + -- Ti -- (-- d --) --] -- + -- Ti -- (-- d --) -- x -- Ti -- (-- u --) -- ** -- Tp -- (-- ud --) -- x -- Tp -- (-- du --) -- ** -- it can carry out -- Vf=Ldx -- {-- [-- Tp -- (-- du --) - Tp -- (-- ud --) --] -- + -- [-- Ti -- (-- d --) - Ti -- (-- u --) --] --} -- /-- [-- two -- xcos (theta) -- xTp -- (-- ud --) -- xTp -- (-- du --) --] -- becoming .
[0011] here -- Vmeas=Ldx -- [-- Tp -- (-- du --) - Tp -- (-- ud --) --] -- /-- [-- two -- xcos (theta) -- xTp -- (-- ud --) -- xTp -- (-- du --) --] -- Verr=Ldx -- [-- Ti -- (-- d --) - Ti -- (-- u --) --] -- /-- [-- two -- xcos (theta) -- xTp -- (-- ud --) -- xTp -- (-- du --) --] -- ** -- carrying out -- if -- Vf=Vmeas+Verr -- becoming -- the rate-of-flow value of truth [Vmeas], and Verr -- the error term of a flow pattern measurement -- becoming .
[0012] Therefore, a flow rate multiplies the rate of flow Vf by the cross section Sr of passage 22, and is as follows.
[0013]
It becomes Qmeas=VmeasxSrQerr=VerrxSr.
[0014] The true flow rate value Qmeas and a true error term Qerr will be acquired.
[0015] In addition, whenever [as opposed to that true rate-of-flow value Vmeas in time when error term / of this rate of flow / Verr or error term's Qerr of flow rate has smaller rate's of flow effect] becomes large. That is, when the rate of flow of a fluid is slow, it is because the value of [Tp(du)-Tp (ud)] becomes very small.
[0016] thus -- since the time amount Ti until the travelling period Tp of the supersonic wave measured (ud) or Tp (du) is detected as the true ultrasonic travelling period Ts, respectively is included -- the ultrasonic transducer of the upstream, and the ultrasonic transducer of the downstream -- when a difference occurs in the time amount Ti (u) and Ti (d) until it is detected, an error will be included in measurement of the rate of flow, and flow rate measurement precision will worsen. That is, a part for the

error in a flow pattern measurement and Ti(d)-Ti(u) ** are contained. In addition, the error term of this rate of flow, Verr (=Ti(d)-Ti (u)), or the error term Qerr of a flow rate (=VerrxSr) is usually called offset value in many cases.
[0017] This invention solves the above-mentioned conventional technical problem, even if a difference occurs in the time amount (Ti) detected by a temperature change or aging between the ultrasonic transducers of a pair (i.e., whether an offset value occurs or it changes), it amends it, and it aims at offering the ultrasonic flowmeter which measures an exact flow rate value.
[0018]
[Means for Solving the Problem] In order to solve said conventional technical problem, the ultrasonic flowmeter of this invention has arranged the ultrasonic transducer of a pair face to face through a fluid to the upstream and the downstream of the passage where a fluid flows, and while measuring the flow rate of a fluid from the travelling period of the supersonic wave which spreads between the ultrasonic transducers of a pair, it considered as the configuration which has the self-checking function which authorizes an offset value from the travelling period of the supersonic wave which goes back and forth between the ultrasonic transducers of a pair.
[0019] By this configuration, whether time amount (Ti) differs while received frequency changes with a temperature change, aging, etc. between the ultrasonic transducers of a pair, or receiving sensibility changed and is detected by carrying out, or an offset value occurs or it changes the ultrasonic flowmeter of this invention, it can amend it and can measure an exact flow rate value.
[0020]
[Embodiment of the Invention] Since invention according to claim 1 can measure and amend the offset value between the ultrasonic transducers of a pair by measuring the travelling period of the supersonic wave which goes back and forth between the ultrasonic transducers of the pair which constitutes an ultrasonic flowmeter, it can measure an exact flow rate value without error.
[0021] Since especially invention according to claim 2 carries out SHINGUA round measurement of the travelling period according to claim 1, it can be amended more to high degree of accuracy.
[0022] Since especially invention according to claim 3 carries out an offset value according to claim 1 when there are few flow rates, it may be the result of being stabilized that there is nothing as for which room for an error to enter becomes empty.
[0023] Since especially invention according to claim 4 carries out an offset value according to claim 1 periodically, it serves as a flowmeter divided and stabilized at the long period of time. Moreover, since it carries out periodically, it also becomes power saving. Moreover, since it can also carry out at any time at the time of check etc., an offset value can also be checked immediately.
[0024] Since the assay result of an offset value according to claim 1 is memorizable, especially invention according to claim 5 can be easily checked, when a problem occurs in an assay result in the future.
[0025] Before and after assay of an offset value according to claim 1, since especially invention according to claim 6 can report the abnormalities in offset when the amount value of flow rates changes a lot, it can respond check etc. immediately.
[0026] Since especially invention according to claim 7 is correctly measurable even if the fluid is flowing, since it asks for the velocity of propagation of the supersonic wave which spreads the inside of a fluid according to claim 1 from the travelling period which goes back and forth between the ultrasonic transducers of a pair, it can detect the temperature of the fluid correctly. Therefore, even if the fluid is flowing, the mask time amount which measures an ultrasonic travelling period can be set up.
[0027] Since especially invention according to claim 8 is correctly measurable even if the fluid is flowing, since it asks for the velocity of propagation of the supersonic wave which spreads the inside of a fluid according to claim 1 from the travelling period which goes back and forth between the ultrasonic transducers of a pair, it can detect the temperature of the fluid correctly. therefore, the temperature display of a fluid -- or temperature conversion of a flow rate value etc. are realizable.
[0028] Since the supersonic wave which spreads the inside of a fluid according to claim 1 is received (i.e., since it transmits and especially invention according to claim 9 receives with the same ultrasonic

transducer), it can authorize the property, especially receiving sensibility of an ultrasonic transducer.
[0029]
[Example] Hereafter, the example of this invention is explained using a drawing. In addition, since what has attached the same number in drawing shows the same thing, it omits explanation.
[0030] (Example 1) Drawing 1 showed the sectional view of the flowmeter 21 in the example 1 of this invention, and countered and installed the ultrasonic transducers 23 and 24 of a pair in the upstream and the downstream of the passage 22 where a fluid flows through the fluid, and the distance Ld between ultrasonic transducers set the cross section Sr of about 100 [mm] and passage 22 to about 30 [mm^2]. In addition, the piece arrow head 25 (continuous line) in drawing shows the direction where a fluid flows, and both the arrow heads 26 (broken line) show the direction which a supersonic wave spreads. In addition, it was made for the direction where a fluid flows to intersect the direction which a supersonic wave spreads on square theta (45 degrees).
[0031] the travelling period Tw of the supersonic wave which reflects on the front face of the ultrasonic transducer of the downstream from the ultrasonic transducer of the upstream, and is detected with the ultrasonic transducer of the upstream in this configuration (ud) -- Tw(ud) =Ld/[Vs+Vfxcos (theta)] -- +Ld/[Vs-Vfxcos(theta)]+Ti(u) = (Ldx2xVs) / [Vs^2-(Vfxcos (theta))^2]+Ti (u)
Here, in the usual case, it is Vs^2>>(Vfxcos (theta))^2.
[0032] For example, when a fluid is air, the rate of flow of flowing fluid of the velocity of propagation Vs of a supersonic wave is abbreviation 1 [mm/sec] -10[m/sec] in general about about 340 [m/sec] and passage.
[0033] therefore, a very small term -- being omissible -- Tw(ud)=(Ldx2xVs)/Vs^ -- it becomes 2+Ti(u) =(2xLd)/Vs+Ti(u) =2xTs+Ti (u).
[0034] The travelling period Tw of the supersonic wave which similarly reflects on the front face of the ultrasonic transducer of the upstream from the ultrasonic transducer of the downstream, and is detected with the ultrasonic transducer of the downstream (du) serves as Tw(du) =2xTs+Ti (d).
[0035] This shows becoming a value independent of the rate of flow of a fluid at the both-way time amount of the supersonic wave measured from the both-way time amount and the downstream of a supersonic wave which were measured from the upstream. That is, even if the rate of flow of a fluid is large and it is small, it becomes the constant value decided by velocity of propagation of the supersonic wave which spreads the inside of a fluid.
[0036] Moreover, when the difference of both-way time amount is calculated, it means that it is set to Tw(ud)-Tw(du) =Ti(u)-Ti (d), and the error term (offset value) in a flow pattern measurement was acquired by measuring the time amount to which a supersonic wave goes back and forth between ultrasonic transducers.
[0037] Therefore, by measuring this error term (offset value) beforehand, the error term (offset value) generated in a flow pattern measurement can be amended, and a flow pattern measurement without an error term (offset value) is made. For this reason, a highly precise flowmeter is realizable.
[0038] The circuit block diagram which while used for drawing 2 in the example of this invention, and transmits with an ultrasonic transducer and is received with the same ultrasonic transducer is shown. 27 is the mechanical component which drives an ultrasonic transducer, and generates a burst signal. 28 and 29 show a diode block and 30 shows an ultrasonic transducer. 31 showed load resistance, 32 showed signal resistance, and it was referred to as 2 and 1 [kohm], respectively. 33 shows the amplifier which amplifies an input signal. In this configuration, the burst driving signal of mechanical components 27-V [several] - dozens V is impressed to an ultrasonic transducer 30 and load resistance 31 through the diode block 28. Near the resonance frequency of an ultrasonic transducer, since the impedance of an ultrasonic transducer is low enough compared with load resistance 31, it is possible that all driving signals are impressed to an ultrasonic transducer, and the supersonic wave of the letter of a burst is emitted from an ultrasonic transducer.
[0039] Moreover, the signal from a mechanical component 27 is impressed also to the diode block 29 and amplifier 33 through the signal resistance 32. In this case, since only the threshold and about 0.9v signal it is decided for diode that will be amplifier since the driving signal of a large electrical potential

difference is connected to touch-down Rhine through the diode block 29 are inputted, amplifier 33 is not destroyed. On the front face of the ultrasonic transducer by which opposite installation is carried out through the fluid, it reflects and the supersonic wave emitted into the fluid returns from an ultrasonic transducer 30. The supersonic wave which has returned is received by the same ultrasonic transducer 30. The received supersonic wave makes an ultrasonic transducer 30 generate a charge. This generated charge makes the both ends of load resistance 31 generate a received electrical potential difference. This received electrical potential difference is small enough, and is usually below 100[mV] extent in many cases. It is delivered a mechanical component to amplifier 33 through the signal resistance 31 through the diode block 28. Even if a sufficiently small received electrical potential difference is grounded with the diode block 29, the received electrical potential difference is transmitted to amplifier 33, without decreasing, since it is below the threshold decided for diode.
[0040] Moreover, since the driving signal supplied to the ultrasonic transducer from the mechanical component 27 is enough decreased while a supersonic wave goes back and forth between [100 / about] ultrasonic transducers [mm], it does not serve as a noise over an input signal. For example, when a fluid is air, the time amount to which a supersonic wave goes and comes back serves as about 590 [musec] extent, and turns into sufficient time amount for a driving signal to decline.
[0041] Thus, the error term (offset value) in flow rate measurement is measurable by measuring the travelling period of the supersonic wave which goes back and forth between ultrasonic transducers. Therefore, since this error term (offset value) can be amended, the precise flowmeter the amount of error is not is realizable.
[0042] (Example 2) Next, the highly precise measurement approach of the both-way time amount by the SHINGUA going [around a course] method is explained.
[0043] Generally the SHINGUA going [around a course] method transmits a supersonic wave from the ultrasonic transducer of a transmitting side, and the transmitted supersonic wave is it being received by the ultrasonic transducer of a receiving side and the signal's being transmitted to the ultrasonic transducer of a transmitting side, and only the count decided beforehand repeating transmission and reception, raising time resolution, and measuring the travelling period of a supersonic wave with high precision.
[0044] Here, the SHINGUA going [around a course] method for having used the time delay Tdelay is explained.
[0045] If the count of a SHINGUA round is set to Nsig and a time delay is set to Tdelay, the both-way time amount Tw (N, ud) in the case of measuring from the ultrasonic transducer of the upstream to the ultrasonic transducer of the downstream The both-way time amount Tw (N, du) in the case of measuring to the ultrasonic transducer of the upstream serves as Tw(N, du) =Nx[Tw(du)+Ti(d)]+NxTdelay from Tw(N, ud) =Nx[Tw(ud)+Ti(u)]+NxTdelay and the ultrasonic transducer of the downstream. In addition, an input signal goes and comes back to a time delay many times, for example, within the limits of 0.7-0.9 of both-way time amount, it was set up so that it might not lap with two round trips or the supersonic wave to which it goes and comes back three times. By this setup, the input signal of high S/N was obtained very small [a noise].
[0046] Since it is Tw(ud) =Tw(du), if the both sides of an upper type are subtracted here Tw(N, ud)-Tw (N, du) =NxTi(u)-NxTi (d) and this -- Nx[Ti(u)-Ti(d)] =Tw(N, ud)-Tw (N, du) -- becoming -- an error term [Ti(u)-Ti (d)] -- N -- double -- it means that the value was acquired the bottom
[0047] the case of 100 SHINGUA rounds (N= 100) which can measure an error term by one times the resolution of N when this place to mean adopts the SHINGUA going [around a course] method -- the clock of 10 [MHz] -- it is -- 1000 [MHz] considerable [nsec], 1 [i.e.,], -- it means that an error term is measurable with considerable resolution. thus, an error term (offset value) -- a high resolution -- it can measure with high precision and a highly precise flowmeter can be realized.
[0048] The example 3 for realizing a flowmeter highly precise than (an example 3) is explained below. In an example 1, as time amount Tw (ud) to which a supersonic wave goes back and forth between [of a pair / Ld] ultrasonic transducers Tw(ud) =Ld/[Vs+Vfxcos (theta)] It gives as +Ld/[Vs-Vfxcos(theta)] +Ti(u) = (Ldx2xVs) / [Vs^2-(Vfxcos (theta))^2]+Ti (u). Although it omitted as mentioned above since it

was Vs^2>>(Vfxcos (theta))^2 in the usual case, in accuracy, it is as follows more.
[0049] Tw(ud)= (Ldx2xVs) / {[Vs^2] x[1-(Vfxcos(theta)/Vs])^2}+Ti -- [1+2xVfxcos (theta)/Vs]+Ti (u) [(u) = (Ldx2) / {Vsx[1-(Vfxcos(theta)/Vs])^2}+Ti(u) **(Ldx2/Vs) x]
Similarly, it is set to [1+2xVfxcos (theta)/Vs]+Ti (d). [Tw(du)**(Ldx2/Vs) x]
[0050] Therefore, when the rate of flow Vf of a fluid is large (for example, when it is air), an error will be set to about 4 [%] if the velocity of propagation Vs of a supersonic wave sets the rate of flow Vf of about 340 [m/sec], theta= 45 [deg], and a fluid to 10 [m/sec]. Moreover, an error will be set to about 0.4 [%] if the rate of flow Vf of a fluid is 1 [m/sec]. Thus, the error becomes small, so that the rate of flow Vf of a fluid is small. about [therefore, / extent / with the rate of flow / (below 1 / for example, / [m/sec]), i.e., flow rate, value conversion] -- it is below 1000 [L/hr] extent, and if an offset value is measured, an error term can be measured more correctly and a highly precise flowmeter can be realized.
[0051] The example 4 for realizing a flowmeter more stable than (an example 4) is explained below. The error term (offset value) of a flowmeter may be changed by the temperature change, aging, etc. every [for this reason, / every day, every week, and every month] -- ** -- the flowmeter stabilized more is realizable by measuring and updating an offset value periodically like. moreover, the environment of a perimeter when forming Exterior SW etc. and moving a flowmeter, or when it installs -- if an offset value is measured and it is made to update when it changes a lot, the flowmeter strong against an environmental variation stabilized more is realizable. Moreover, if an offset value is measured and it is made to update by remote operation etc. from the exterior, the flowmeter stabilized more is realizable. The flow rate value measured in these cases is supervised, fluctuation of the minimum flow rate value measured is interlocked with, and you may make it measure and update an offset value. That is, when the minimum flow rate value is displayed as negative, it is good to measure and update an offset value. The reliable flowmeter stabilized over the long period of time of dozens of [several years -] is realizable with this configuration.
[0052] (Example 5) Below, an example 5 is explained. It can make realizable the flowmeter whose amendment of the abnormalities of a flow rate value is enabled while enabling detection of the abnormalities of an offset value of an example 5.
[0053] That is, in the example 5, the offset storage section is prepared in a flowmeter and the offset value before and behind the modification time of an offset value and updating was memorized. When an offset value is updated by this configuration exceeding a certain fixed width of face from the offset value for example, at the time of shipment, it also becomes possible to judge with a flowmeter being unusual. Moreover, reporting to a flowmeter installer also becomes possible in that case using a communication line etc. Moreover, the display which reports abnormalities to the outer surface of a flowmeter is prepared, and it becomes possible to also make it indicate by abnormalities there. Moreover, for example, also when abnormalities occur in an addition flow rate value, it also becomes possible to check the past addition flow rate value and to carry out rough amendment from the offset value memorized by the flowmeter storage section. Thus, while making the abnormalities of an offset value detectable, the flowmeter whose amendment of the abnormalities of an addition flow rate value is enabled is realizable with the configuration which memorizes the modification time of an offset value, and an updating value.
[0054] (Example 6) Below, an example 6 is explained. In the flowmeter by the example 6, the fixed threshold in the change in the updating value per time of an offset value was established. When the threshold of this increase and decrease of a value was beforehand set as about 1 [L/hr] as for example, a flow rate reduced property and this value is exceeded, it becomes possible [also judging with a flowmeter being unusual, or also reporting using a communication line etc., if it becomes possible and judges with it being unusual]. Moreover, you may make it prepare the display which reports abnormalities in a flowmeter front face. In addition, you may make it the threshold of this increase and decrease of a value interlocked with updating time amount. For example, as long as updating time amount is one month, you may make it set the threshold as about 3 [L/hr] extent. By this configuration, the abnormality judging of a flowmeter can be carried out for every renewal of an offset value. A flowmeter with the stable, always high dependability is realizable.

[0055] (Example 7) The measurement circuit block diagram of the flow meter in an example 7 is shown in drawing 3 . In this configuration, a trigger circuit 34 outputs a start instruction to the drive circuit 27 and the time amount circuit 35 at spacing set up beforehand. In the drive circuit 27 which received the start instruction, the driving signal which becomes the transmitting-side ultrasonic transducer (for example, ultrasonic transducer 3 of the upstream) chosen by the transmitting-side change-over SW36 from a burst signal is outputted. The supersonic wave which the transmitting-side ultrasonic transducer transmitted into the fluid of passage is received by the ultrasonic transducer (for example, ultrasonic transducer 4 of the downstream) chosen by the receiving-side change-over SW37, and the signal is amplified with amplifier 33. On the other hand, the timer pulse of fixed spacing is generated in the time amount circuit 35 which received the start instruction. Moreover, a gate disconnection signal is sent out to a detecting circuit 38 after the gate released-time (Tgk) progress for which it opted beforehand. In the detecting circuit 38 which received the gate disconnection signal, party rhe ****** is operated, a zero crossing point is detected from the received wave of a supersonic wave, and ultrasonic time of delivery is detected. The true travelling period Ts of a supersonic wave and the time amount Ti until it is detected after arriving at the front face of an ultrasonic transducer are included in this detection time amount. Using this detection time amount, a true ultrasonic travelling period is calculated and the rate of flow Vmeas of a fluid is calculated in control and an arithmetic circuit 39. this rate of flow and Vmeas from -- the flow rate value Qmeas is computed and a flow rate value is acquired. In order to decide a gate released time (Tgk) at this time, the time amount which goes back and forth between the ultrasonic transducers of the pair shown in the above-mentioned example is used.

[0056] That is, the time amount to which, as for the time amount to which the supersonic wave measured from the ultrasonic transducer of the upstream goes and comes back, the supersonic wave with which it measured from the ultrasonic transducer of Tw(ud) =2xTs+Ti (u) and the downstream goes serves as Tw(du) =2xTs+Ti (d).

[0057] Here, since it is simply decided from the frequency which an ultrasonic transducer uses since it is decided like a part for 3.5 waves, Ti (d) and Ti (u) can compute easily the time amount Ts to which a supersonic wave goes and comes back truly. In addition, since Ti (d) and Ti (d) are values decided by the property of the ultrasonic transducer of the upstream and the downstream or a transmitting side, and a receiving side, and zero cross setup, they are the value which can be decided beforehand roughly. From this, it could decide on the time amount Ts which a supersonic wave spreads truly, and by this example, from this time amount Ts, it is the following, and the gate released time Tgk was made and decided.

[0058] That is, it considered as Tgk=Ts+ (a part for 3.0 waves).

[0059] This is explained using drawing 4 . the drive wave which drawing 4 becomes from a burst signal -- 40 and the received wave of a supersonic wave -- 41 is shown. time amount until it makes the origin of time amount measurement into the standup point 42 of a burst wave of a driving signal, Ts shows a true ultrasonic travelling period and about 295 [musec] and Ti is detected after a supersonic wave's arriving at the front face of an ultrasonic transducer, and number - more than ten [musec] are shown. Ti is a sufficiently small value compared with Ts. Tgk shows the gate released time shown above, and Tp shows the detection time amount of the supersonic wave detected by the zero crossing point 43 obtained in a detecting circuit 38. At this time, KOPARETA was set up so that the zero crossing point of a gate released time, Tgk, and next negative inclination might be detected. Therefore, the zero crossing point of a gate released time and the forward inclination just behind Tgk does not detect. As explained above, the rate of flow of a fluid is measured by setting up a gate released time (Tgk) and detecting the travelling period of the supersonic wave from the upstream to the downstream, Tp (ud) and the travelling period of the supersonic wave from the downstream to the upstream, and Tp (du) from the time amount to which a supersonic wave goes and comes back. In this case, since it is measurable as the above-mentioned example also explained the offset value from the both-way time amount of a supersonic wave, it can amend and a highly precise flowmeter can be realized. Moreover, the electrical-potential-difference setup 9 (Vref) of the comparator shown in this case in drawing N becomes unnecessary. therefore -- even if a received wave becomes unstable by the temperature characteristic, an environmental variation

or aging, etc. -- the travelling period of a supersonic wave -- being stabilized -- exact -- being measurable -- high degree of accuracy and quantity -- a stable flowmeter is realizable.

[0060] (Example 8) If the time amount to which a supersonic wave goes back and forth between ultrasonic transducers is measured with the ultrasonic transducer of the upstream, and the ultrasonic transducer of the downstream, as the above-mentioned example 1 showed, it will serve as Tw(ud) =2 xTs+Ti(u) Tw(du) =2 xTs+Ti (d), respectively.

[0061] therefore, the travelling period Ts of the supersonic wave which spreads the inside of a fluid -- Ts= (Tw-Ti)/2 -- therefore, the velocity of propagation Vs of a supersonic wave becomes Vs=Ld/[(Tw-Ti) /2].

[0062] In addition, since Tw (ud) and Tw (du) were comparable large **, they described it as Tw, and since Ti (u) and Ti (d) were comparable large **, they described it as Ti. Moreover, Tw is about 590 [musec] extent and Ti is divisor - more than 10 [musec] extent. Therefore, it can be regarded as Tw>>Ti and the acoustic velocity Vs of a supersonic wave is as follows.

[0063] Vs= -- a supersonic wave can measure the velocity of propagation Vs which spreads the inside of a fluid in this way 2 xLd/Tw. The temperature requirement where the velocity of propagation of a supersonic wave and the temperature of a fluid which will spread the inside of the fluid if the class of fluid is decided are broad according to the science chronology etc. is shown by the linear function. Therefore, the temperature of a fluid is able to be measured if the acoustic velocity (velocity of propagation) of a supersonic wave was found.

[0064] For example, in air, the velocity of propagation Vs of a supersonic wave will become Vs=341.45+0.607xt[m/sec], if temperature of air is set to t [**].

[0065] From this relation, the temperature of air is detectable from the acoustic velocity of a supersonic wave.

[0066] The thing in reference temperature to do for temperature compensation of carrying out flow rate value conversion also becomes possible about the measured flow rate value, using the temperature of this fluid. Moreover, it also becomes possible to display the temperature of the measured fluid on a flowmeter.

[0067] Thus, according to the flowmeter of this invention, a supersonic wave can measure the temperature of a fluid easily from the time amount which goes back and forth between ultrasonic transducers, and the flowmeter in which temperature compensation and a temperature display are possible can be realized.

[0068] (Example 9) An example 9 is explained below. In the both-way time amount measurement circuit block of the supersonic wave shown in drawing 2 , the driving signal of a fixed electrical potential difference is impressed to an ultrasonic transducer from a mechanical component 27, and a supersonic wave goes back and forth between fixed distance (i.e., between the ultrasonic transducers of a pair), and is received by the same ultrasonic transducer. By detecting the magnitude of this input signal, transmission / receiving property of an ultrasonic transducer can be evaluated and authorized. That is, initial value is memorized in the storage section and it becomes possible to deteriorate to 0.5 of the value and to judge a time to be degradation of an ultrasonic transducer. In this case, evaluation and assay of the upstream and the downstream can be done independently. Therefore, it becomes possible [specifying a degradation criterion as the difference of the received electrical potential difference between the ultrasonic transducers of the upstream and the downstream]. In the conventional flowmeter, transmission / receiving sensibility of the supersonic wave from the upstream to the downstream or the upstream from the downstream was evaluated and authorized. In this case, since the property of the ultrasonic transducer of the upstream and the downstream had become the evaluation and assay which became entangled intricately, it was undetectable even if either deteriorated. Even if degradation was detectable, it was not able to distinguish that which ultrasonic transducer deteriorated.

[0069]

[Effect of the Invention] As mentioned above, according to invention according to claim 1 to 9, the offset value between ultrasonic transducers can be detected and amended, and a highly precise ultrasonic flowmeter can be realized.

[Translation done.]